

# VISUAL INSPECTION SYSTEM AND SIPPING DESIGN FOR SPENT FUEL AT TRIGA MARK III REACTOR OF MEXICO

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## ABSTRACT

This paper describes the Visual Inspection System designed and constructed at ININ-Mexico as part of the activities of the Regional Project RLA/04/18 “ Management of Spent Fuel from Research Reactors in Latin America “. This activity was financed in part by the IAEA.

## INTRODUCTION

Since the regional project of spent fuel management from research reactors aims to review and propose options for temporal and definitive storage, there is a need of verifying the integrity of spent fuel and cladding to ensure proper operation and safe handling and decide if those fuels have to be packed to be transport and store. Visual inspection of fuel elements with an underwater camera will show visual evidence of defects such as bowing, cladding blisters, pinholes, pits, cladding cracks or tears, mechanical damage to cladding etc., and will facilitate evaluation to determine if those defects exceed the indicated limits.

The participant countries of the regional project RLA/04/18 “Management of Spent Fuel from Research Reactors in Latin America” decided that each participant country should have a Visual Inspection System and share data and experience in this matter with the other participants. The countries that did not have a system should construct one , Mexico received equipment from the IAEA for the system.

The system has a high resolution camera Hydro-Technologie model VSLT 410N *fig.1* designed to work underwater until 30 m and environments of 0° to 50 C and dose rates up to 50 rad/h, also a control unit *fig. 2* that allows remote operation of the camera.



Figure 1 Camera HYTEC VSLT



Figure 2 Control Unit

The design basis for the system were defined and included the need of doing fuel inspection below water , at least, 3 m below of the pool surface, ensure safe handling of the spent fuel, fuel integrity of the spent fuel, verticality of the fuel, total access to the entire surface to be inspected.

The Visual Inspection System basically is formed by three parts. The Structural Frame., The Camera with its Control Unit and the Imaging Acquisition Unit.

### THE STRUCTURAL FRAME

Is a set of pieces assembled together that allows to fix it to the upper channel of the aluminum liner of the reactors pool, support the fuel elements and displace the camera vertically to inspect the fuel. *Fig 3.*

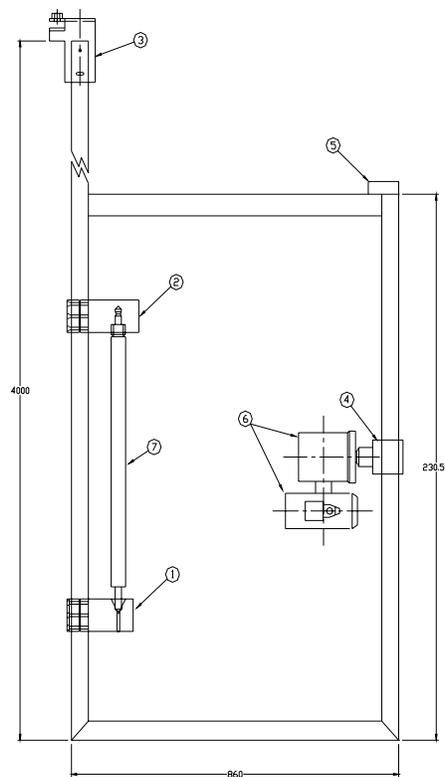


Figura 3. The structural frame

The frame is made of aluminum, Nylamid and fixed with stainless steel bolts, the aluminum tubes that conform the frame were drilled to allow free circulation of water to facilitate the introduction and positioning of the frame in the water. The fixing support made of aluminum plate of 6.35 mm is bolted to the aluminum liner channel to ensure enough rigidity *fig 4*



Figura 4 Fixing Support

The upper and lower supports are made of two pieces of Nylamid of 7.62 cm thickness, the lower support stands the weight of the fuel element, the upper support gives stability to the fuel element and allows the free entrance of the fuel and the special fuel handling tool and also supports the rotation indicator device put to verify the rotation movement of the fuel element. Also was placed a ruler to measure the position of the indications *fig 5,6,7and 8*.

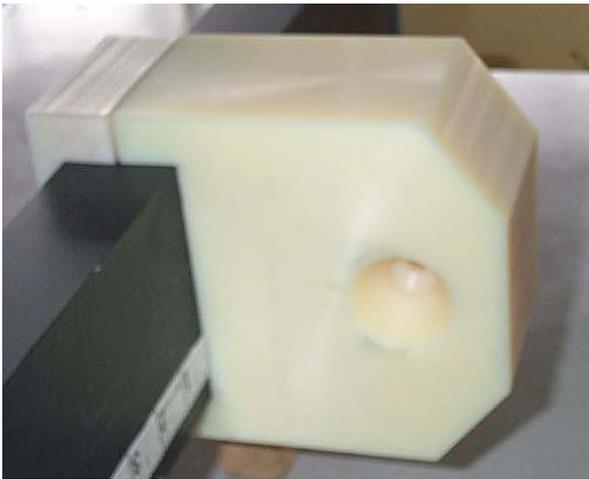


Figure 5.Lower Support

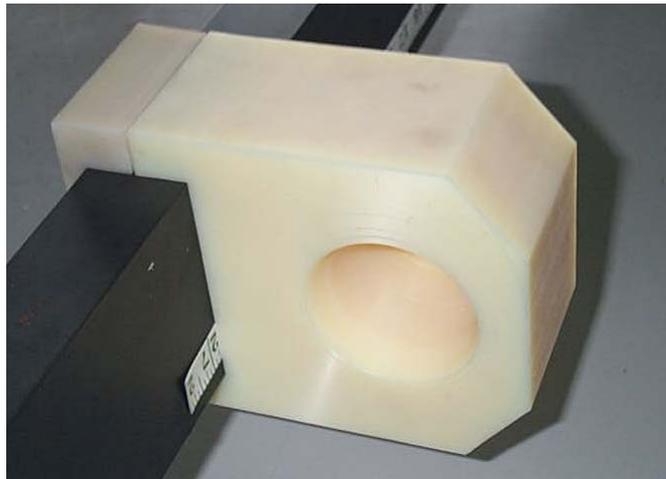


Figure 6 Upper Support



Figure 7 Rotation Indicator Device



Figure 8 Ruler

### THE IMAGING ACQUISITION SYSTEM

The imaging acquisition system uses an external device AverMedia *fig 9* which function is decoding the video signal coming from the control unit and sending it to the computer where the signal is processed and captured on color video or static pictures. The system has the following features:

- Allows seeing the video on the screen while working at the computer
- Capture of imaging or video
- Video up to 30 fps
- Formats JPEG and RGB
- Supports formats NSTC, PAL-N, PAL-M



Figure 9 External Device

## CONCLUSIONS

A Visual Inspection System was designed and constructed at ININ-Mexico which provides the capability of inspecting Triga spent fuel elements to evaluate cladding and fuel integrity by means of high resolution digital images and/or video.

The system combined with the software Quantikov, provided by Mr. L. Pinto from IPEN-Brazil proved to increase the analysis capability of the system. The software allows to obtain the distribution of areas and volumes of micro particles, grains and pores and other parameters such as form factors, perimeter, rate of superficial area per unit of volume etc. the software has a friendly user design.

An example is shown in *fig 10, 11 and 12* in the figure 10 it is shown the upper part of an irradiated Triga fuel element of the Triga Mark III reactor core, when Quantikov is used the fuel is seen as in figure 11 here with more detail it can be observed the upper part of the fuel –lighter that the rest- were the graphite is located, and in the middle of the fuel we can see a small scratch . Using Quantikov tools we can find the diameter of the fuel (3.73 cm) the distance from the top to the scratch (16.84cm ) and the size of the scratch ( 1.04 cm ). Figure 12 shows the negative of the fuel imaging where the defect is better seen.



Figura 4.1 Irradiated Fuel

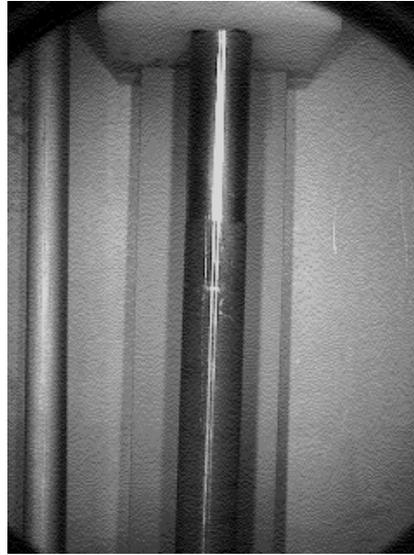


Figura 4.2 Fuel with Quantikov

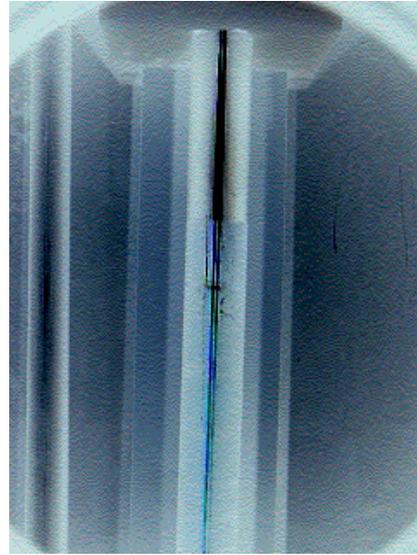


Figura 4.3 Negative of Fuel with Quantikov

### FUEL SIPPING

At this moment, the sipping system has been designed and is been constructed, the principal features is that the fuel element is going to be cased in a tube that will provide with a turbulent water flux to clean up the surface since with have indications of some small contamination on the fuel surface. Also, we are going to include some electrical heating because at room temperature in a Triga fuel element should be difficult to detect leaking.

### BIBLIOGRAPHY

1. TRIGA Mark III Reactor Hazard Analysis. General Atomics G A 6469, June 14 CNEN, 1965.
2. TRIGA Mark III Reactor Mechanical Maintenance and Operating Manual for CNEN Gulf General Atomic GA-6610 July 17, 1968
3. Technical Specifications, Safety Analysis Report, TRIGA Mark III Reactor. Chapter 14, 2001-
4. L. C. Pinto, Quantikov Image Analyzer for Windows 98, Ph. D. Thesis USP/IPEN, June 1996.